

3M (MMM)

Hold: \$185

PFAS Primer: in the chemical crosshairs

Company Update

This in-depth report reviews the history of production, product application, regulation and litigation of PFAS – human-made fluorinated chemicals that provide oil and water repellency, temperature/heat resistance, and friction reduction – including recent trends and developments, and potential costs, overall and for 3M.

PFAS chemicals have been scientifically linked to cancer and other diseases. PFAS contamination is increasingly more widespread than previously thought. Hundreds of PFAS contamination sites have officially been identified, affecting the drinking water of millions of Americans – with potentially thousands more contamination sites to be uncovered, based on trends. Furthermore, PFAS are considered even more dangerous because the chemicals bioaccumulate – significant levels of PFAS can accumulate in the blood even if a person were to live in an area with minimal PFAS concentration. PFAS traces are reportedly found in the blood of all humans.

PFAS remediation can be costly – ranging from a few million dollars to several hundred million dollars per site and requiring many years, while often not completely cleaning up the contaminated site. Ultimately, remediating PFAS just in the US could end up costing **\$25bn to \$40bn**, if not more. In turn, we would expect 3M, a legacy primary manufacturer of PFAS chemicals for decades, to pay a substantial portion of that clean-up bill.

There are hundreds of PFAS contamination sites identified in the US. This total is expected to steadily increase (ie, into the thousands, and possibly many thousands). In turn, PFAS litigation (individual, class-action, State) has been rapidly increasing – fueled by more stringent State and EPA actions to regulate, test and remediate PFAS, as well as the precedent established by remediation and lawsuit settlements against manufacturers, including the pivotal Leach v. DuPont case.

We have developed 2 frameworks for assessing 3M's PFAS liability for remediation and personal injury litigation. Our Bottom-up framework pegs 3M's US liability at an average of **\$6bn+**, based solely on litigation cases filed to date. Our Top-down framework estimates 3M's US liability at an average of **\$22bn+**, based on contaminated sites identified to date. Note that these estimated ranges could prove conservative, depending on the outcome for precedent trials, as well as tightening regulation and the discovery of new contamination sites. Moreover, we do not assume punitive or property damages, which could dramatically increase the cost. However, favorable trial verdicts (ie, for defendants) could push the manufacturer liability in the opposite direction.

Overall, the remediation and litigation progression for PFAS would still appear to be in relatively early days. In turn, the final bill for 3M could end up substantially greater than what the markets are presently assuming. At present, we believe MMM is discounting mostly PFAS remediation costs pertaining to the company's past PFAS manufacturing sites. At minimum, we expect PFAS to potentially overhang and contain 3M's equity valuation for an extended period.

Multi-Industry Team

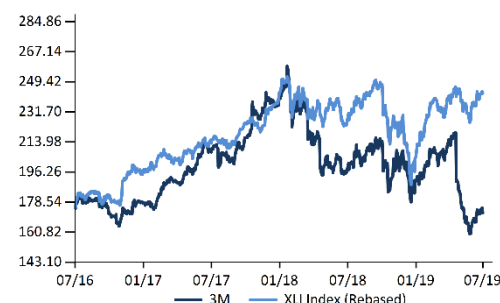
John G. Inch
212-404-0607
jinch@gordanhaskett.com

Ivana Delevska
212-404-0609
idelevska@gordanhaskett.com

Company Data

Price: Close	\$172.00
Price Target	\$185.00
% to Price Target	7.6%
52-Week Range	\$159 - \$220
Market Cap (M)	\$99,145
Avg. Daily Vol. (000)	1,741

MMM Price Performance



Forecasts & Ratios

EPS (\$)	2017A	2018E	2019E	2020E
Q1 (Mar)	2.16	2.50	2.23	-
Q2 (Jun)	2.58	3.07	2.11	-
Q3 (Sep)	2.33	2.58	2.68	-
Q4 (Dec)	2.10	2.31	2.68	-
FY EPS	9.17	10.46	9.70	10.50
Street	9.17	10.46	10.59	11.47
GAAP EPS	-	-	-	-
P/E	18.8x	16.4x	17.7x	16.4x
EV/EBITDA	11.8x	11.5x	12.5x	11.8x
FCF Yield (%)	4.6	4.7	5.3	6.0

Table of Contents

PFAS synopsis	3
AFFF contamination – military and airport focus.....	6
Regulatory review	8
Tighter EPA regulations forthcoming	8
Recent State actions on PFAS.....	9
Adverse human health impacts.....	11
Expensive to clean up.....	13
Sizeable 3M liability.....	14
Bottom-up analysis: sizeable liability based solely on cases filed.....	15
Top-down analysis: as cases increase, so does the liability	17
I. Liability related to 3M’s manufacturing facilities	19
II. State Attorneys General	21
III. Aqueous Film-Forming Foam (AFFF).....	22
IV. Customer sites	26
Leach v. DuPont – history and implications	27
Case study: Hoosick Falls NY	29
Chemours vs. DuPont liability	31
Punitive damages not in our analysis	32
What is priced-in for 3M.....	32

PFAS synopsis

PFAS – polyfluoroalkyls and perfluoroalkyls – are a family of human-made fluorinated chemicals that provide oil and water repellency, temperature/heat resistance, and friction reduction (making things slippery). There are thousands of PFAS compounds. PFAS are ubiquitous in consumer and industrial products. The 2 principal PFAS substances of concern are perfluorooctane sulfonate (**PFOS**) and perfluorooctanoic acid (**PFOA**).

PFOA, perhaps best known for its use in the production of Teflon™, was primarily manufactured by 3M and DuPont (now Chemours). PFOA was created as a byproduct of other chemical processes and was first used in the manufacture of commercial products in the late 1940s. 3M was the only apparent US manufacturer of PFOS, which forms the key ingredient in the production of Aqueous Film Forming Foam (AFFF). AFFF was used for decades as a fire suppressant to fight tough (eg, petroleum-fueled) fires – particularly at oil and chemical facilities and military bases. PFOS, also produced since the 1940s, was additionally used in the production of fabric protectors such as Scotchguard™ and semiconductor devices, among other products.

PFOA and PFOS are comprised of long-chain molecules that are considered both highly toxic (100 to 1,000 times more toxic than most other mobile contaminants such as benzene, MTBE and chlorinated degreasers) and highly troublesome as the contaminants do not readily break down in the environment. PFOA and PFOS bind to proteins which makes them particularly problematic for people and animals. According to the US EPA, there is evidence that exposure to PFOA can lead to adverse health outcomes. Extensive study (the C-8 Science Panel) has found “probable link” between exposure to PFAS and 6 known diseases: testicular and kidney cancer, thyroid disease, ulcerative colitis, pregnancy induced hypertension and diagnosed high cholesterol.

One of the concerning traits of PFAS is that the chemicals bioaccumulate (in the food chain and in humans). Even if a person were to live in an area with only slightly elevated PFAS, significant levels of PFAS may still accumulate in the blood. Traces of PFAS reportedly can be found in the blood of all humans.

Recent analysis indicates that PFAS contamination is much more widespread than previously thought. At present, PFAS have been found in the drinking water of more than 19 million Americans in 43 states, although this is not to suggest that the drinking water for that many Americans is toxic. According to a study by the Environmental Working Group (EWG), a non-profit organization, and the Social Science Environmental Health Research Institute, there are now at least **610 known locations across 43 states** in the US that have been contaminated with PFAS as of **Mar/19** – up from **172** contamination sites across 40 states as of **Jul/18**. Among the 610 are 117 military sites including 77 DOD airports (discussed in the next section).

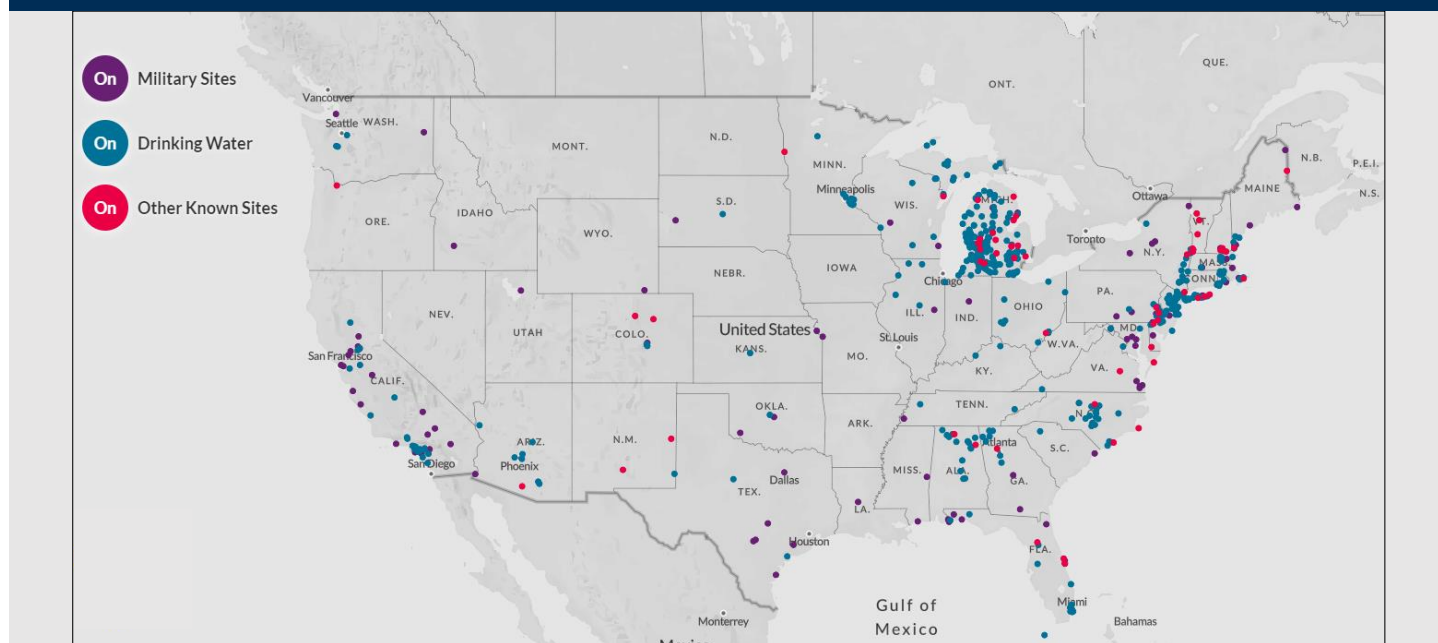
In terms of the contamination locations, Michigan currently has the most sites at 192. California has 47 known PFAS contamination sites followed by New Jersey at 43. See Fig 1 for EWG’s most recent PFAS contamination site map that includes public water systems, military bases, military and civilian airports, industrial plants, dumps/landfills and firefighting training sites. Note that at the time the map was last published in Mar/19, there were several State water sampling programs such as in Michigan that were just underway. Consequently, the next iteration of the EWG site map is expected to reveal continued expansion in the number of known PFAS contamination sites.

By the end of 2019, the **EPA** will propose a regulatory determination as part of the process of establishing a Maximum Contaminant Level (MCL) for PFAS that would require all public water systems to test for PFAS and pursue remediation where required. The EPA has also begun the regulatory development process for listing PFOA and PFOS as hazardous substances under the Superfund Act, which could substantially raise the level of remediation required across existing and future PFAS contamination sites. In turn, this would likely place significant new cost pressures on the manufacturers such as 3M as the EPA could prospectively compel these companies to remediate designated PFAS contamination sites or pay for the clean-up – advancing the clean-up cost timeline (vs. the litigation route). In addition, the scope of the site contamination (and required clean-up) could be readily expanded to non-water sites such as landfills which potentially number in the thousands.

The PFAS Action Act of 2019, currently sponsored with bipartisan support in Congress, would *require* the EPA to designate PFAS as hazardous substances under Superfund – *removing any doubt* re the listing of PFAS as hazardous substances.

Moreover, the establishment of an MCL for PFAS would undoubtedly lead to the discovery of (many) other PFAS contamination locations as all public water systems would subsequently be required to be tested, which is not the case today under the current “advisory” guidelines, while presumably also being tested against more stringent contamination thresholds. (Intuitively, many more contamination sites exist, particularly at lower PFAS concentration levels.) **Overall, it is estimated there are potentially thousands, and possibly tens of thousands, of additional drinking water, groundwater and other sites that have been contaminated with PFAS to be exposed.**

Figure 1: Rising PFAS contamination in the US



Source: EWG, GHRA; published May 2019; data as of March 2019

Apart from the EPA, State authorities have selectively been stepping up their water testing for PFAS while State regulations for PFAS concentration levels are generally becoming more stringent. For instance, the PFAS standards in New York, New Jersey and Vermont are at or moving to levels substantially below the current advisory levels of the EPA. Note that presently 12 states have established some level of PFAS drinking water standard (see Fig 6).

In the aftermath of the Flint water scandal, **Michigan** is currently conducting a sampling program to test as many as 11,000 sites which are suspected to retain some level of PFAS contamination – including 1,400 fire stations, 27 airports, 104 military bases, refineries, landfills, electroplating facilities and wastewater treatment plants. At roughly the half-way point in the study, more than **650 public water supplies surveyed have tested positive for PFAS above the EPA’s current health advisory levels** (compared to 192 Michigan sites shown in the EWG map).

Just this past March, **California** announced a plan to systematically obtain more robust content data of PFAS within its drinking and groundwater (“PFAS Phased Investigation Plan”). Phase I involves testing at over 1,500 airports, landfills and drinking water wells across the state. Phase II includes testing at refineries, bulk

terminals, non-airport fire training areas and urban fire areas. Phase III includes testing at secondary manufacturers, wastewater treatment plants and domestic drinking water wells.

Both the states of New Jersey and New York have also aggressively been boosting actions to raise public awareness of PFAS contaminants.

Experts at Nathan Inc, an environmental remediation and litigation consultancy, estimate that 10,000 to 20,000 sites in the US could ultimately be deemed to require remediation from PFAS contamination, with up to 100,000 sites that could be found to contain some level of PFAS. **With an average estimated cost for site remediation at ~\$2.0-2.5mm, the total bill for just cleaning up PFAS in the US could range from \$25bn to \$40bn.**

Figure 2: US PFAS remediation cost estimate

Site count estimate	10,000	20,000
Cost per site (\$ mm)	2.5	2.0
Total remediation (\$ bn)	25	40

Source: Nathan, GHRA

Meanwhile, State, class action and individual litigation to remediate and/or sue for damages related to PFAS have been steadily increasing – propelled by more stringent government regulations and PFAS contamination threshold guidelines. 3M has reportedly already incurred hundreds of \$ millions in remediation and PFAS study and analysis costs while booking in excess of \$1bn in environmental remediation charges. DuPont’s settlement of the Leach case (discussed in detail later in this report), which ultimately cost the company ~\$1bn, provides a key precedent for estimating costs related to studying and medically monitoring PFAS contamination and for personal injury claims which we have used as a basis for estimating the potential personal injury/damage costs to settle cases that have been filed to date.

From a bottom-up perspective (based on litigation cases filed), we estimate 3M’s total environmental and personal injury litigation bill, on top of charges already taken, at between \$4.6bn and \$8.1bn. Our analysis assumes no incremental 3M remediation costs to clean up its manufacturing sites and is based solely on litigation cases filed vs. cases that might be filed in the future. (See Fig 3 for our Bottom-up analysis summary table; Fig 8 provides the details for our Bottom-up analysis.) However, the likely discovery of potentially thousands of new PFAS contamination sites coupled with the presumed associated litigation expansion could meaningfully inflate that eventual cost. For example, we would expect 3M to pay a substantial portion of the previously noted estimate of \$25-40bn for total PFAS clean-up in the US. Moreover, our analysis does not estimate punitive damages that could be assigned by the law courts which could add many \$ billions to the final PFAS bill.

From a top-down perspective (based on 610 identified contamination sites), we estimate 3M’s potential PFAS liability at between \$16.5bn and \$29.0bn. Our analysis is based solely on the 610 contamination sites already identified and assumes all 610 will have to be remediated, which ultimately may not be required depending on the level of contamination at each of the 610 sites. However, the discovery of new contamination sites (hundreds to thousands) could push the final bill well above our estimated range. We applied the aforementioned Leach settlement as a precedent for personal injury and also assigned an average of ~\$48mm per site clean-up cost for environmental remediation, based on our discussions with experts. (See Fig 4 for our Top-down analysis summary table; Fig 9 provides the details for our Top-down analysis.) As in the Bottom-up scenario analysis, our Top-down estimates for 3M personal injury costs presume a settlement structure vs. individual trials that result in higher awards (to the plaintiffs) and/or the imposition of punitive damages.

In both scenarios, individual trials that side in favor of the defendants, for instance, could reduce 3M’s prospective PFAS liability. However, unfavorable verdicts could similarly push the personal injury costs for 3M and others in the opposite direction.

Figure 3: 3M PFAS liability – Bottom-up analysis summary (\$ millions)

Environmental Remediation

3M Manufacturing Sites	-	-
State Remediations	1,750	2,800
AFFF	420	630
Customer Sites	210	420
	<hr/> 2,380	<hr/> 3,850

Personal Injury

3M Manufacturing Sites	825	825
AFFF	1,075	3,075
Customer Sites	325	325
	<hr/> 2,225	<hr/> 4,225

Total 3M Potential Liability	4,605	8,075
-------------------------------------	--------------	--------------

Source: Company Reports, Leach vs. DuPont settlement, GHRA

Figure 4: 3M PFAS liability – Top-down analysis summary (\$ millions)

Environmental Remediation	23,400	34,600
Medical Monitoring	1,000	1,000
Personal Injury	30,500	61,000
Total PFAS Liability	54,900	96,600

3M Responsibility (30%)	16,470	28,980
--------------------------------	---------------	---------------

Source: EWG, GHRA

Overall, the remediation and litigation progression for PFAS would still appear to be in relatively early days. In turn, the final bill for 3M, while perhaps unlikely to create near term financial stress, could end up substantially greater than what the markets are presently assuming. Moreover, we believe PFAS increasingly injects a significant element of risk into the 3M equity investment equation – not dissimilar to the legacy issue of asbestos with other manufacturers – that appears at least likely to suppress 3M’s ability to regain a significant valuation premium for an extended period. While we see no significant incremental near-term cash costs, we see a building overhang, as the number of cases increases (see details around timing of cases and other developments below).

AFFF contamination – military and airport focus

As noted, Environmental Working Group has identified and mapped **117 military sites** in the US where drinking water or groundwater is contaminated with PFAS at levels that exceed the EPA’s current guidelines.

Last year, the Pentagon disclosed there are **401 sites** where there are known or suspected releases of the two best-known PFAS chemicals (PFOA and PFOS), and 90 sites where PFAS testing results exceeded the EPA health guidelines.

Figure 5: Pentagon identifies more than 400 military sites for possible PFAS contamination

Branch of service	Total sites with known or suspected release of PFOS/PFOA (as of 8/31/17)	Sites sampled where results exceeded EPA health guideline (as of 8/31/17)	Groundwater wells sampled	Groundwater wells that tested above the EPA guideline
Army	64	9	258	104
Navy/Marine Corps	127	40	1,368	784
Air Force	203	39	1,022	719
Defense Logistics Agency	7	2	20	14
Total	401	90	2,668	1,621

Source: DOD, EWG, GHRA; March 2018

Aqueous Film Forming Foam (AFFF) – used for decades for fire suppression – contains PFOS and constitutes the source of the PFAS contamination for the majority of the military sites. 3M manufactured PFOS from 1963 to 2002 (the company announced the voluntary phase-out in May 2000). PFOS used in AFFF eventually washes or seeps into the groundwater – polluting the drinking water of the local communities.

Since 2015, the government has been phasing out the use of PFAS in fire-fighting foam. The Air Force completed the transition in 2018. The Army will phase out PFAS this year. The Navy will eliminate PFAS by 2020. It is not clear where the government has been sourcing PFOS/AFFF since 3M discontinued its manufacture in 2002 (ie, potentially from overseas suppliers, or from previous stockpiles). Per 3M, the stated shelf-life for 3M military specification AFFF was at least 25 years when properly maintained.

The DOD has reportedly estimated that military's AFFF clean-up bill could total \$2bn. PFAS experts with whom we have spoken believe that estimate to be conservative.

In addition to military sites, AFFF has been widely used at public and private airports both for fire suppression and training, as well as at petroleum and chemical refining, production and storage sites. According to the Bureau of Transportation Statistics, there are ~20,000 airports in the United States – many of which could be potential PFAS contamination sites. There could be hundreds to thousands more other sites linked to the petroleum and chemical industries.

At least nine states are considering policies to ban the use of PFAS in firefighting foam. Washington state passed a ban on the use of PFAS in firefighting foam last year. States reportedly considering bans include AK, CT, MI, MN, NH, NY, RI, VA, VT. In addition, in Apr/18, the House of Representatives passed legislation that would direct the Federal Aviation Administration to rewrite regulations to require the use of PFAS-free firefighting foams at commercial airports. The bill is still before Congress.

Regulatory review

Tighter EPA regulations forthcoming

There are currently no federal drinking standards or mandates for PFAS. In May 2016, the EPA released a non-enforceable Lifetime Health Advisory (LHA) of **70 parts per trillion (ppt)** threshold content for drinking water – one ppt is also known as a nanogram/liter or ng/L – for PFOA and PFOS, individually or combined. This level was substantially revised down from the previously advisory level of **400 ppt for PFOA and 200 ppt for PFOS** that was set in 2009. However, as we understand it, without an enforceable PFAS standard (ie, a “Maximum Contamination Level” or MCL directive), public water systems are not required to (routinely) test for PFAS or to treat/remediate water found to exceed the EPA’s LHA. Consequently, there is currently no comprehensive assessment of the prevalence of PFAS in the US drinking/groundwater supply.

However, it is widely expected that the EPA, which is under tremendous public pressure to more forcefully address PFAS issues and increase the regulation of PFAS, is likely to move to initiate the MCL process at the beginning of next year – per the EPA’s Feb 14/19 announcement of a “Comprehensive PFAS Action Plan”. Note that the EPA has never previously issued a PFAS MCL. Moreover, the MCL would presumably also lower the current (LHA) PFAS threshold to <70 ppt. For instance, scientists for the **Agency for Toxic Substances and Disease Registry (ATSDR)**, a division of the Department of Health and Human Services, released a report last year (June 20/18) that concluded that the “minimal risk level” for exposure to PFOA and PFOS should be **seven to 10 times lower** than the EPA’s LHA of 70 ppt (ie, closer to ~10 ppt). At a recent PFAS conference held in Washington, several participants reportedly expect the EPA to ultimately issue its new PFAS MCL that establishes PFAS concentration thresholds at **close to ~10 ppt** (ie, similar to the lower end of recent State actions and the ATSDR’s recommendation). At minimum, we expect the EPA MCL to be accompanied by more stringent PFAS contaminant thresholds vs. the current LHA of 70 ppt.

An MCL from the EPA would also require all US water utilities to test for PFAS and comply with the new (lower) ppt limits. In turn, this would be expected to substantially boost the discovery of known PFAS contamination sites due to the new mandated testing for PFAS across the US coupled with the lower thresholds for contamination. Moreover, all State regulations regarding PFAS contaminant thresholds would likely move to at least the revised (lower) federal standards – states would not want to expose themselves legally with more “lax” environmental regulation than the EPA. **In turn, we would anticipate a subsequent wave of additional PFAS-related litigation post an MCL from the EPA as many new PFAS contamination sites are identified, similar to the manner in which PFAS litigation began to ramp higher after the May 2016 EPA (LHA) downward revision to 70 ppt.**

The EPA has also begun the regulatory development process to list PFOA and PFOS as hazardous substances under the Superfund Act and will issue interim groundwater clean-up recommendations for sites contaminated with PFOA and PFOS. This action plan was released on February 14, 2019. The Superfund Act establishes liabilities for polluters that is retroactive to the Superfund’s enactment in 1980. It also establishes joint and several liability such that any one potentially responsible party (PRP) may be held liable for the entire clean-up of the site (when the harm caused by multiple parties cannot be separated). In addition, a PRP cannot simply say that it was not negligent or that it was operating according to industry standards. If a PRP sent some amount of the hazardous waste found at the site, that party is typically liable.

In turn, the listing of PFAS as hazardous substances could substantially raise the level of remediation required across existing and future PFAS contamination sites, placing significant new cost pressures on the manufacturers such as 3M as the EPA could prospectively compel companies to remediate designated PFAS contamination sites or pay for the clean-up (ie, without intervention from the law courts), advancing the clean-up cost timeline vs. the litigation route. Moreover, the scope of the site contamination (and required clean-up) could be readily expanded to non-water sites such as landfills which potentially number in the thousands.

The PFAS Action Act of 2019, currently sponsored with bipartisan support in Congress, would require the EPA to designate PFAS as hazardous substances under Superfund – *removing any doubt* re the listing of PFAS as hazardous substances.

Recent State actions on PFAS

Given the absence of enforceable federal standards, 12 US states have adopted or proposed their own health-based drinking water guidelines for PFOA and/or PFOS, ranging from 13 to 1,000 ppt (ng/L). Several states have established guideline levels below EPA's current LHA of 70 ppt, suggesting that significant numbers of regulators and scientists view the EPA's policy as insufficiently protective. Some of the more recent PFAS contamination levels that have been established are in the **~10 ppt range**.

In just the past few months, several states have also started conducting statewide sampling programs, including New York, New Jersey, Pennsylvania, Michigan and California. In addition, Colorado, for example, is reportedly holding extensive hearings on the subject of PFAS.

In Dec 2018, the **New York** Drinking Water Quality Council (DWQC) recommended a state-wide MCL of 10 ppt for each PFAS compound individually (PFOA and PFOS). In turn, it is estimated that **over 20%** of all NY public water systems would test at unsafe levels of PFAS (above 10 ppt) under this mandate. At a threshold of 4 ppt, it is estimated that **over 40%** of NY public water systems would test at unsafe levels of PFAS. The remediation cost to comply with prospective recommended levels of 10 ppt is estimated at \$855mm in capital and \$45mm in ongoing annual operations and maintenance costs, according to the NY Department of Community Water Systems.

In March 2019, the **New Jersey** Department of Environmental Protection proposed an MCL of 14 ppt for PFOA and 13 ppt for PFOS. This regulation would place 39 public water systems over the limit for PFOA and 19 for PFOS. Of those, only ~15 are currently working on addressing PFAS contamination. In addition, the New Jersey Department of Environmental Protection (NJDEP) recently (Mar/19) issued a directive ordering five chemical companies plus 3M and DuPont/Chemours to fund the removal of certain PFAS chemicals contained in natural resources, such as drinking water.

In May 2019, **Michigan's** Attorney General announced a nationwide search for experts (on a contingency basis) to help pursue legal action over PFAS to pay for required remediation at potentially thousands of contaminated drinking water sites. The requests for proposals are for attorneys and law firms — anywhere in the country — that have the experience and resources to pursue claims against "manufacturers, distributors and other responsible parties" related to PFAS contamination.

Later that month, the state of **New Hampshire** filed 2 PFAS lawsuits — one against 3M and DuPont/Chemours related to PFOA, PFOS, PFNA (a derivative of PFOA), and the other one related to fire-fighting foam (AFFF) against 3M, DuPont/Chemours, Chemguard, Tyco Fire Products and other companies. The lawsuits are pursuing the companies to recover damages associated with investigation, clean-up and monitoring of the State's natural resources that have been contaminated by PFAS.

In April 2019, the **Pennsylvania** Department of Environmental Protection (DEP) announced a plan to conduct a statewide per- and polyfluoroalkyl substances (PFAS) sampling to identify impacted drinking water supplies. The sampling plan reportedly started in May 2019 to test water taken from more than 300 public water systems based on proximity to common sources of PFAS. The DEP has also announced that it is beginning the process of setting a Maximum Contaminant Level (MCL) for PFAS since the EPA has not committed to taking regulatory action.

Figure 6: Select PFOA drinking water guideline levels

State/ Organization	Standard	Level	Critical effect study	Refrence dose
U.S EPA *	Health Advisory Level (HA)	70 ng/L	Lau et al.	20 ng/kg-day
Alaska DEC	Ground water clean up level	400 ng/L	Lau et al.	20 ng/kg-day
Maine DEP	Remedial action guideline	130 ng/L	Six studies combined	6 ng/kg-day
Minnesota DOH	Non-cancer health-based level	35 ng/L	Lau et al.	20 ng/kg-day
New Jersey DEP	Maximum contaminant level (recommended)	14 ng/L	Loveless et al.	2 ng/kg-day
North Carolina DENR	Interim maximum allowable concentration (proposed)	1,000 ng/L	Butenhoff et al.	N/A
Texas CEQ	2017 Protective concentration level	290 ng/L	Macon et al.	15 ng/kg-day
Vermont DEC/DOH	Primary groundwater enforcement standard	20 ng/L	Lau et al.	20 ng/kg-day
California	Drinking water notification guideline	14 ng/L		
New York	Maximum contaminant level (recommended)	10 ng/L		
Colorado	Groundwater quality standard for El Paso County only	70 ng/L		
Michigan *	State standard for concentration of PFAS in drinking water	70 ng/L		
Massachusetts *	State guidance for concentration of PFAS in drinking water	70 ng/L		
Washington	Proposed drinking water standard			

*individually and combined PFOA/PFOS

Alaska, Maine, North Carolina and Texas follow the EPA's HA for public and/or private drinking water

Source: Environmental Science & Technology Journal, GHRA

Adverse human health impacts

DuPont reportedly began studying PFOA and toxicological exposure-related concerns in the 1960s.

Per the Leach case, internal company documents reveal that DuPont was aware of the dangers of PFOA as far back as 1961. By 1984, the company apparently knew that PFOA was both present in the local water supply and also being emitted as dust particulate from its factory chimneys. Neither concern was disclosed to DuPont workers or the local public.

3M reportedly started measuring fluorine levels in blood samples from its workers in the 1970s. In 1997, 3M sampled and detected elevated PFOS in blood serum from its workers and in samples from US blood banks – representing the control population. The company initiated several studies during the subsequent years that confirmed widespread PFAS exposure to the US population.

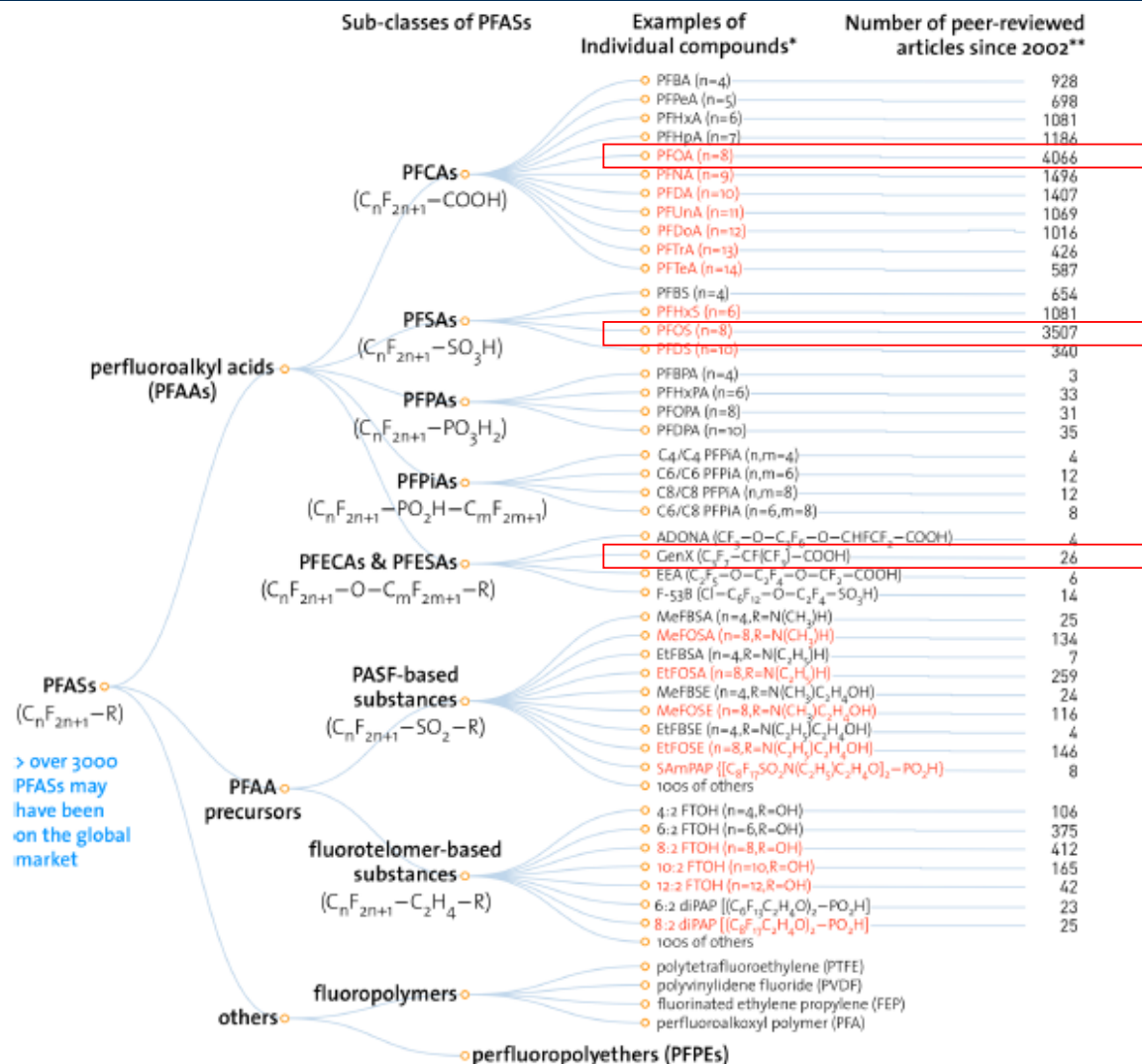
3M manufactured PFOA (aka C-8) – a processing agent used in the production of Teflon™ – from the 1950s through 2002. DuPont subsequently manufactured C-8 for roughly a dozen years after that time (ie, since 3M's announced phase-out in 2000).

The most extensive PFOA health effects study ever conducted pertained to the Leach Case (Leach v. DuPont) that started with ~70,000 participants, residents of the Mid-Ohio Valley, who were blood tested and monitored for several years. The testing was conducted by the "C-8 Science Panel". Ultimately, the extensive study found "probable link" between PFOA or C-8 exposure and six health conditions in ~5% of the test population: **testicular and kidney cancer, thyroid disease, ulcerative colitis, pregnancy induced hypertension, and diagnosed high cholesterol.** (See DuPont Leach Case section later in this report.)

However, there have also been studies conducted by regulatory authorities that have not found a link between PFAS and health injuries (including Minnesota State of Health and New York State). Note these studies did not perform blood testing, but instead relied on publicly available statistics (eg, the New York Health Study examined existing cancer rate data in the NYS Registry over a 20-year period). Since, **surveys** of the actual population from the New York State study show significantly higher rates of the 6 identified diseases per the C-8 Science Panel Study (see Hoosick Falls Case later in this report).

As noted, one of the concerning traits of PFAS is that the chemicals bioaccumulate (in the food chain and in humans), so even if a person lived in an area with only slightly elevated PFAS in the water, for example, significant levels of PFAS may still have accumulated in the individual's blood, over time. Traces of PFAS reportedly can be found in the blood of all humans.

Figure 7: Sub-classes of PFAS and associated scrutiny



* PFASs in **RED** are those that have been restricted under national/regional/global regulatory or voluntary frameworks, with or without specific exemptions (for details, see OECD (2015), Risk reduction approaches for PFASs. <http://oe.cd/1AN>).
 ** The numbers of articles (related to all aspects of research) were retrieved from SciFinder® on Nov. 1, 2016.

Source: Environmental Science and Technology Journal, GHRA; highlighted are PFAS molecules discussed in this report

Expensive to clean up

In recent weeks, we have held discussions and hosted events with environmental remediation experts. According to one firm, PFAS clean-up around a manufacturing site is often extremely difficult, time consuming and costly (often exceeding \$100mm, even for a relatively small site). Soil incineration is reportedly one of the most effective methods of cleaning up the land and removing PFAS, but can be prohibitively expensive (ie, ~\$3,000/ton). There is apparently no chemistry solution for PFAS remediation as some of the PFAS molecular bonds apparently cannot be broken by known science. In general, groundwater has to be pumped to the surface and filtered using expensive activated carbon filtration systems – a process that can go on for years.

Large manufacturing site PFAS remediation can cost significantly more than \$100mm. For instance, last year 3M took a charge of \$850mm for environmental remediation primarily related to the company's Cottage Grove MN facility. The charge included no punitive damages, but did include some funding for environmental conservation – eg, "habitat and recreation improvements".

There are a handful of PFAS manufacturing sites in the US. 3M operated 3 production sites where PFAS was manufactured (Cottage Grove, MN; Cordova, IL; and Decatur AL) while DuPont operated 3 large sites where PFAS was used in the production of Teflon™ (Parkersburg, WV; Fayetteville, NC; and Chamber Works, NJ) as well as some smaller sites. Note that DuPont manufactured PFOA only in Fayetteville, NC after 3M announced it would discontinue its production of long chain PFAS in 2000.

A significant number of current remediation cases outstanding reportedly tie to customer sites that used PFAS and did not dispose of the chemical properly – eg, carpet, apparel, chemical manufacturers, airports and military bases that used AFFF.

Based on our discussions with industry experts, PFAS filtration systems for individual drinking water wells could cost an average of \$1-1.5mm (for small sites) and ~\$5mm for a local "well system" that could form the source for a 30,000 to 50,000 person municipality's drinking water. Note too that **advanced activated filtration remediation apparently does not completely eliminate PFAS content**, but can bring the level of PFAS from ~100 ppt to ~10 ppt, for example. Usually, it is also significantly more expensive to install filtration systems for highly contaminated sites. While sites with contaminant levels touching 1,000 ppt might be able to be remediated down to 500 ppt, for example, this would still substantially exceed the EPA's LHA as well as the thresholds set by most of the States that are actively regulating PFAS – raising questions regarding the purpose (and \$ spent) for attempted remediation of highly contaminated sites in the first place.

A PFAS plume can extend 3-miles+ while impacting numerous properties. The scope of remediation at a given PFAS contamination site could encompass treating community water supplies, providing point-of-use treatment systems, cleaning up landfills (that could number in the thousands nationwide), treating biosolids (eg, farmland contamination), as well as incurring related litigation and compliance costs. In turn, associated remediation actions could ultimately require hundreds of monitoring wells, multiple groundwater pumping and treatment systems, and on-site source control. Consequently, a given site's remediation bill per site can range dramatically, from installing a discrete well filtration system (\$1-1.5mm) to >\$100mm to tackle a larger, more expansive remediation.

Sizeable 3M liability

3M is facing several layers of liability related to PFAS.

1. The company is expected to incur significant clean-up costs pertaining to its **3 US and 2 overseas PFAS manufacturing sites**. As noted, 3M has already spent hundreds of \$ millions in remediation and PFAS study and analysis costs while booking in excess of \$1bn in environmental remediation charges.
2. Multiple States are establishing drinking water maximum contaminant levels (MCLs) and requiring water utilities to comply with the new standards. In turn, **State attorneys general (AGs) are suing 3M and others** to recover the compliance and remediation costs of the new regulations (eg, New York, New Jersey, New Hampshire).
3. There is a large **fire-fighting foam (technically known as “film forming foam” or AFFF) multi-district litigation (MDL)** working its way through the courts related to fire suppressant foam used at military bases and airports that was manufactured by 3M with PFOS and sold mostly to government specifications. 3M manufactured and marketed AFFF from approximately 1963 to 2002. The foam has ostensibly ended up contaminating ground and surface water surrounding hundreds of sites. Note that 85 cases (as of Dec/18; now in excess of 100) against 3M and others have been consolidated under the MDL that have included remediation and personal injury cases.
4. Several of **3M’s customers** are being sued, along with the PFAS manufacturers (3M and DuPont/Chemours) for improper disposal of PFAS. These lawsuits comprise both remediation and personal injury cases. The personal injury cases have been citing precedent from Leach v. DuPont as well as findings from the C-8 Science Panel.

It is important to note that 3M has, thus far, only settled remediation cases (eg, Minnesota with the State, Alabama with a water utility). The company essentially maintains there is no scientific proof that PFAS causes health injuries and is therefore generally unwilling to settle personal injury cases. Still, the remediation financial risk alone, apart from potential personal injury, property damages and punitive damages, cannot be dismissed. As previously discussed, experts with whom we have consulted estimate medium to large-scale individual site clean-up can run in excess of \$100mm.

Regarding personal injury cases, according to 3M, 2 cases (one in the US and one in Europe) that have gone to trial have resulted in “not guilty” verdicts. Even so, personal injury cases filed against 3M have been increasing, particularly post the Leach settlement and C-8 Science Panel that found “probable link” between PFAS and 6 diseases. The outcome of the AFFF MDL, which could begin to emerge next year, is likely to prove pivotal for 3M as a determinant of future remediation costs and personal injury liability for existing and potentially thousands of still uncovered PFAS contamination sites.

Ultimately, PFAS is not just a US issue. For instance, the company manufactured PFAS in Belgium and Germany. However, our liability analysis is confined to the US as it is based on cases currently filed – the company has not provided disclosure regarding prospective non-US liability other than the aforementioned \$235mm remediation charge that includes clean-up at its 2 overseas PFAS production facilities.

As noted in this report’s opening “synopsis”, experts estimate that 10,000 to 20,000 sites in the US could ultimately be deemed to require remediation from PFAS contamination, with up to 100,000 sites that eventually could be found to contain some level of PFAS, over time. **With an average estimated cost for site remediation at ~\$2.5mm, based on a 10-20K site total, the eventual bill for remediating PFAS in the US could range from \$25bn to \$40bn.** In turn, we would expect 3M to ultimately pay a sizeable portion of that amount.

Note that litigating remediation (vs. personal injury or other product claims) could ultimately prove an easier path for plaintiffs to pursue. For example, establishing that 3M and other companies are liable for (personal injury) harm could prove challenging given that no signature disease has thus far (yet) been directly established as having been caused by PFAS exposure (vs. “probable link”) – although the basis of toxicology

analysis, as we understand it, is correlation vs. scientific “causation”. Still, according to Roux, a worldwide environmental and litigation management consultancy, courts could find it difficult to side against future plaintiffs who develop one of the 6 probable link (with PFAS) diseases who live in the contamination site regions. Moreover, the courts could still order (costly) medical monitoring as part of a process for establishing personal injury that is likely to take many years. (See our takeaways from our conference call with Roux and replay “[PFAS Round 2](#)”.)

To determine 3M’s prospective PFAS liability, we performed both a “Bottom-up” and “Top-down” analysis.

Bottom-up analysis: sizeable liability based solely on cases filed

Our Bottom-up approach suggests a total 3M remediation and personal injury liability of ~\$4.6-8.1bn. As noted, a significant determinant of future liability would appear to depend on the outcome of the AFFF MDL. Included in the \$4.6-8.1bn range, we estimate the **liability for AFFF at (~\$1.5-\$3.7bn)** – split roughly 20-30% remediation and the balance for prospective AFFF personal injury. Note that our range estimate is based solely on cases that we have identified (eg, 3M 10-K disclosure) as currently filed – there could be other cases pending which have not been captured in our framework. Our estimate would also exclude punitive damages (vs. a settlement structure) for cases that go to trial that could be awarded and ultimately prove to be substantial (eg, Roundup precedent). (See Fig 8 for the math behind our ~\$4.6-8.1bn estimate.)

Our analysis is based on the payout precedent of the Leach v. DuPont settlement. **Given the increasing number of lawsuits being filed against 3M, our estimate could increase considerably in the future** – particularly given aforementioned tightening regulation and increasing PFAS water testing (eg, “hazardous” designation/Superfund, future EPA MCL). Moreover, the concept of (proliferating) property damage cases could inject a whole new layer of 3M liability that could still play out over many years.

The 15-20 AFFF (MDL) sites would seem to have an average of 30,000+ people living around each. To calculate the prospective 3M AFFF liability, we assume only 10,000 to 30,000 people in the vicinity of each AFFF site, to provide for a greater level of conservatism. We also apply an assumed 5% disease incident rate, consistent with the C-8 Science Panel study in the Leach v. DuPont case. Consequently, the eventual personal injury liability would (somewhat intuitively) screen as less likely vs. the remediation liability where the company has already been paying substantial clean-up sums at its former manufacturing sites (establishing precedent). That said, we are still assuming significant personal injury liability for 3M, including pertaining to the company’s large manufacturing plant in Decatur, Alabama (>\$800mm).

Given that plaintiffs are suing more parties than just 3M, we assign 70% of the remediation bill to 3M – recall, in the use of AFFF and associated lawsuits, 3M was the only US manufacturer of PFOS. In the calculation of 3M’s personal injury (share of cost), we assign 50% of the cost tally to 3M. (See Fig 8.)

Figure 8: 3M Bottom-up US PFAS liability estimate (based on existing cases)

				Number of states/sites	Cost per site (\$ millions)		Total cost (\$ millions)	
					Low	High	Low	High
I A	ENVIRONMENTAL REMEDIATION							
	3M Manufacturing Sites							
	Minnesota, Illinois, Alabama			3	-		-	-
II A	State Remediations NY, OH, MI, NJ, NH (multiple sites per state)							
	Total State Remediation Cost			5	500	800	2,500	4,000
	3M Liability (70% of total)						1,750	2,800
III A	AFFF - Remediation			15	40	60	600	900
	3M Liability (70% of total)						420	630
IV A	Customer Sites - Remediation			6	50	100	300	600
	3M Liability (70% of total)						210	420
	Total Environmental Remediation			29			2,380	3,850
Population size				Monitoring (\$ millions)	Personal injury (\$ millions)		Total cost (\$ millions)	
I B	PERSONAL INJURY							
	3M Manufacturing Sites - Alabama			275	550	550	825	825
III B	AFFF Personal Injury for 20 Sites			150	2,000	6,000	2,150	6,150
	3M Liability (50% of total)						1,075	3,075
IV B	Customer Sites Personal Injury							
	Hoosick Falls, NY			23	109	109	132	132
	Cooper Township, MI			16	31	31	47	47
	Coosa River, AL			50	100	100	150	150
	Kennebunkport, MA			18	36	36	54	54
	Penns Grove, NJ			64	128	128	192	192
	Blades, DE			25	50	50	75	75
	Total Customer Sites Personal Injury			195	455	455	650	650
	3M Liability (50% of total)						325	325
	Total Personal Injury			620	3,005	7,005	2,225	4,225
	Total 3M liability						4,605	8,075

I A. Assume 3M's \$850mm MN settlement and \$235mm supplemental reserve sufficiently covers the remediation liability

II A. Assumes 100-150 smaller sites requiring \$5mm filtration systems per site; or 5-10 large site remediation estimated at ~\$100mm/site for each state (NY State, for example, estimates the cost to comply with the new standard at ~\$855mm). Michigan AG announced intention to file a lawsuit

III A. ~20 AFFF sites facing lawsuits (consolidated in the SC MDL); estimate all will require remediation; estimate remediation range based on average of \$5mm cost for filtration system (small site) to ~\$100mm+ for medium to larger site (~\$50mm average); approx. 5 of the 20 AFFF sites included in the state Attorneys General litigation

IV A. Customer sites - cases filed against 3M (company supplied PFOA to a customer); not all law suits seek a specific remediation amount - assume all sites will require some level of remediation. Alabama Water Utility settled > \$35mm - would be considered small/medium site

I B. Leach v. DuPont Settlement applied to the affected population (\$5,000 per person for monitoring; 5% of the population injured; \$200K per person settlement)

III B. Leach v. DuPont Settlement \$ applied to the affected population; note that Leach not directly applicable (PFOA vs. PFOS) resulting in significantly more uncertainty; actual population sizes ~30K around each of the 20 sites; assume smaller affected population for base case; medical monitoring assumes 1 site (used as a precedent)...if testing performed (entire population), liability would shift significantly higher

IV B. Customer sites include litigation disclosed in 3M 10K + Blades, DE case filed in May/19

Source: Company Reports, Court Filings, GHRA

Top-down analysis: adding up the liability based on sites

In contrast with our Bottom-up analysis that assessed 3M's liability based on existing court cases, our Top-down analysis – which debatably could be viewed as more of a “worst case” framework based on contamination sites identified – assumes all 610 identified PFAS contamination sites in the US require remediation while local residents are compensated for personal injury in a settlement structure similar to the Bottom-up analysis, based on Leach case precedent. Our derivation of clean-up cost (\$38-57mm per site) was based on consultation with industry experts.

Our top-down analysis estimates a total US remediation and personal injury cost of \$55-97bn, of which we peg 3M's potential liability at \$16.5-29.0bn.

It is important to note that not all the 610 identified contamination sites contain PFAS levels above the 70 ppt EPA advisory level. Hence, our Top-down approach could be viewed as more stringent. That said, with the EPA's standard likely to move lower and the number of contamination sites likely to continue to expand, the final bill could indeed end up more comparable to the Top-down scenario, if not above.

For each of the contamination sites, we assume 5,000 to 10,000 average population size which could prove conservative, especially as at least some of the contamination sites are located in or near relatively populated areas (airports, etc.).

Overall, we assume 30% of the (Top-down) liability falls to 3M – this estimate may also prove to be conservative considering 3M may have manufactured up to ~85% of all PFAS globally. That said, as it is still in early innings with respect to PFAS litigation, it is difficult to predict how the courts are likely to view 3M's responsibility. Per litigation experts with whom we have consulted, while it is generally the *customer's* responsibility to handle products responsibly, there have been cases (eg, MTBE) where the manufacturers have been held responsible for remediating pollution damage caused by customers.

Our derived total average remediation bill for the industry of \$29bn (\$23-35bn range) would align with the aforementioned estimated range of \$25-40bn. Our estimate of the bill for a personal injury settlement ranges from \$31bn to \$61bn. We also assume medical monitoring costs of ~\$1bn as part of the derivation of industry liability, which appears to be reasonable to conservative – particularly if the law courts begin to mandate more widespread medical monitoring analysis as part of the class-action process. (See Fig 9.)

Figure 9: 3M Top-down PFAS liability estimate

	Population size		Number of sites	Cost per site (\$ millions)		Total cost (\$ millions)		
				Low	High	Low	High	
				Environmental remediation				
a.			AFFF Remediation Currently Filed	20	40	60	800	1,200
			AFFF Potential	100	30	40	3,000	4,000
			AFFF Remediation	120	35	50	3,800	5,200
			Remaining Sites	490	40	60	19,600	29,400
b.			Total Remediation	610	38	57	23,400	34,600
c.			Medical Monitoring (portion of sites)	20			1,000	1,000
d.	Personal Injury (all sites)	5,000	10,000	610			30,500	61,000
			Total Liability				54,900	96,600
			3M Liability (30% of total)				16,470	28,980

a. Assume all 120 currently identified AFFF sites remediated; \$40-60mm estimate for the first 20 sites and slightly smaller estimate for the remaining sites; water filtration systems cost \$5mm/site with total remediation for a small/medium site in excess of \$100mm

b. Assume remaining 490 sites remediated at average cost of a medium site; the number of total sites could significantly increase post state-wide testing actions

c. Assume medical monitoring cost of \$1bn that would cover 20 sites with estimated population of ~10,000 and cost of \$5,000/person (per Leach)

d. Personal injury applies Leach v. DuPont precedent (5% of population with disease and \$200K/person settlement) to all 610 sites, based on significantly lower assumed population per site (5-10K vs. 70K in Parkersburg, WV)

Source: Company Reports, EWG, GHRA

The following (numbered) sections tie back to our Bottom-up analysis framework for 3M personal injury and remediation liability (from Fig 8). Recall, this analysis pertains only to litigation filed.

I. Liability related to 3M's manufacturing facilities

For decades, 3M manufactured PFAS at 5 production locations – 3 sites in the US: Cottage Grove (Minnesota), Cordova (Illinois), and Decatur (Alabama), and 2 sites overseas: Belgium and Germany.

The company is facing both remediation and personal injury claims directly pertaining to its manufacturing sites and associated environmental contamination. Note that while there has been significant discussion thus far (by the company) around remediation, 3M hasn't said much on the personal injury front except to essentially refute that PFAS causes disease and that more scientific discovery is required.

3M has reached several remediation settlements and is in process of working with various government agencies to either clean up PFAS sites with contaminated groundwater or cap the sites. Last year, 3M settled with Minnesota over Cottage Grove. The company remains in ongoing litigation (and settlement discussions) regarding its 4 remaining manufacturing sites.

In 1Q19, 3M took a \$235mm charge which reflected the company's best estimate of the liability to clean up all of its remaining manufacturing sites outside of Minnesota. The company stated that the 1Q19 charge **does not** encompass (personal injury) cases where 3M has sold products containing PFAS which have subsequently been found in the environment, as it was not possible to estimate at the time (including lawsuits pertaining to AFFF and other customer sites discussed later in this report).

On Feb 20, 2018, the state of **Minnesota** settled its lawsuit against 3M for **\$850mm**. The lawsuit was initiated in 2010 when the Minnesota AG filed suit against 3M alleging that the company's production facilities damaged the State's drinking water and natural resources. In September 2017, the State's damages expert submitted a report that argued for **\$5bn** in damages. A week before the trial was set to begin, the Minnesota Department of Health released its own health impact analysis, which stated that it could find no evidence of higher rates of cancer or birth defects in the affected region. The subsequent settlement with Minnesota pertained only to environmental liability and did not cover personal injury while punitive damages were dropped.

The company has been performing a significant amount of remediation work, under the supervision of State regulators, to clean-up manufacturing sites in both Alabama and Illinois. Per discussions with the company, 3M had previously spent **over \$600mm** for environmental remediation even before the Minnesota settlement.

In 2014, the **Illinois EPA** approved a request by 3M to establish a groundwater management zone at its manufacturing facility in Cordova, which includes ongoing pumping of the impacted site groundwater, groundwater monitoring, and routine reporting of results.

In **Alabama**, the company entered into a voluntary remedial action agreement with the Alabama Department of Environmental Matters (ADEM) pertaining to its Decatur site. After a review of the available options to address PFAS in the soil, ADEM agreed to a preferred remediation option that applied a multilayer cap over the former (PFAS infested) sludge areas in proximity to the manufacturing site, with subsequent groundwater migration controls and treatment applied. The construction of the cap was reportedly completed in 2018.

In April 2019, the company settled a lawsuit with the West Morgan - East Lawrence Water Authority in AL for \$35mm – a large sum for only a small water utility. According to filings, 3M will also cover the costs of any current and future lawsuits against the water authority alleging liability or damages related to PFAS. In this case, the water authority's complaint was tied to the Decatur site – illustrating that 3M pursuing remediation (with a State) does preclude future litigation pertaining to its former PFAS production site(s). Moreover, in this instance, while the market may have potentially interpreted this settlement as covering all of Alabama, in fact the \$35mm covered just one (small) water authority (vs. a blanket settlement with the entire State).

Per 3M's 10-K filings, there remain several cases outstanding pertaining to Alabama water contamination, including several large recent cases on the part of residents of Morgan county seeking compensatory and punitive damages related to PFAS for personal injury and property damage.

Figure 10: Litigation related to 3M Decatur, Alabama (manufacturing site)

Case	Date filed	Description/ Plaintiffs	Charges	Defendants
ALABAMA				
St. John Case	2002	1 former employee filed putative class action	Property damage	BFI Waste Management, City of Decatur, Morgan County, Municipal Utilities Board of Decatur; and Morgan County, Alabama
Chandler Case	2005	3 residents of Morgan County filed putative class action	Property damage	3M
Stover Case	2009	1 resident of Franklin County filed putative class action	Property damage	3M
West Morgan - East Limestone Water Utility	Oct-15	<i>Settled case - April 2019</i>	<i>3M will pay for new filtration system (>30mm)</i>	<i>3M, Daikin America</i>
Riverkeeper	Jun-16	Nonprofit corporation	Violation of Resource Conservation and Recovery Act declaratory and injunctive relief	BFI Waste Systems of Alabama; the City of Decatur; the Municipal Utilities Board of Decatur
Residents of Lawrence/ Morgan County	Aug-16	200 customers of Water Utility filed putative class action	Personal injury and property damage	West Morgan-East Lawrence Water and Sewer Authority (Water Authority), 3M, Dyneon, Daikin, BFI, and the City of Decatur
Customers of Water Authority	Jan-17	Several hundred plaintiffs	Personal injury / compensatory and punitive damages	3M, its subsidiary Dyneon, and Daikin America in Lawrence and Morgan Counties, Alabama
King	Nov-17	Putative class action	Personal injury / compensatory and punitive damages	3M, Daikin, Water Authority
Individual (similar to "King Case")	Sep-18	Individual plaintiff	Personal injury / compensatory and punitive damages	

Source: Company Reports, GHRA

For Alabama, applying the Leach case \$ precedent and a ~55,000 affected population estimate, **we calculate the 3M potential liability related to personal injury could equate to ~\$550mm.** In addition, we estimate another ~\$275mm related to medical monitoring, adding up a total of **~\$825mm**, or roughly in-line with the Minnesota settlement.

II. State Attorneys General

As previously noted in the regulatory section of this report, several States have adopted more stringent rules than the EPA's 70 ppt PFAS LHA. In addition to setting tighter standards for PFAS, several AGs are pursuing legal action against 3M.

As an example, the Michigan Attorney General is seeking outside legal experts to help with potential lawsuits involving PFAS. The AG is considering legal strategies to hold 3M and other PFAS manufacturers liable for widespread PFAS contamination of drinking water.

Generally, the filed lawsuits cover multiple large sites that are known to have contamination. Moreover, state-wide water testing programs concurrently underway would seem likely to result in additional lawsuits.

We are assuming a \$2.5-4.0bn liability for the 5 States that have currently filed lawsuits (including Michigan that has stated its intention to file). In turn, we estimate the cost at **~\$500-800mm per State** based on the assumption of at least 5-10 relatively large sites per State that would require clean-up costing \$50-100mm, or alternatively 100-150 smaller sites requiring the establishment of new \$5mm filtration systems at each site (ie, for States with state-wide testing programs).

This per State cost estimate aligns with the NY State estimate that it will cost ~\$855mm to bring the State into compliance with its proposed new PFAS standards, apart from \$45mm in incremental ongoing annual operations and maintenance costs.

Figure 11: State Attorneys General PFAS lawsuits

Per 3M 1Q19 10-Q

New York	AG lawsuit regarding damages to natural resources
Ohio	AG lawsuit requesting compensatory and punitive damages
Michigan	TBD - AG announced intention to file a lawsuit

Filed since 1Q 19

New Jersey	AG - National Resource Damage along with other damages and penalties
New Hampshire	AG files two lawsuits: (1) PFOA/PPFOS related; (2) AFFF related

Source: Company Reports, GHRA

III. Aqueous Film-Forming Foam (AFFF)

In the early 1960s, the Navy worked with 3M to develop firefighting foams containing a combination of PFAS chemicals. In 1969, the military adopted specifications requiring the use of AFFF foams for fire training and emergencies. Per company filings, 3M manufactured and marketed AFFF for firefighting purposes at airports and military bases from approximately 1963 to 2002.

In its 2016 10-K, 3M disclosed for the first time that 7 class actions had been filed against 3M and other defendants in Colorado and Pennsylvania, alleging that the plaintiffs suffered personal injury and property damage from drinking water contaminated with certain PFCs used in AFFF. Furthermore, it was disclosed that the Town of Barnstable, MA, had filed an individual action against 3M and other suppliers of AFFF seeking compensatory and punitive damages for alleged contamination of the aquifer supplying drinking water to the Hyannis water system. The number of AFFF cases disclosed has continued to expand in subsequent filings.

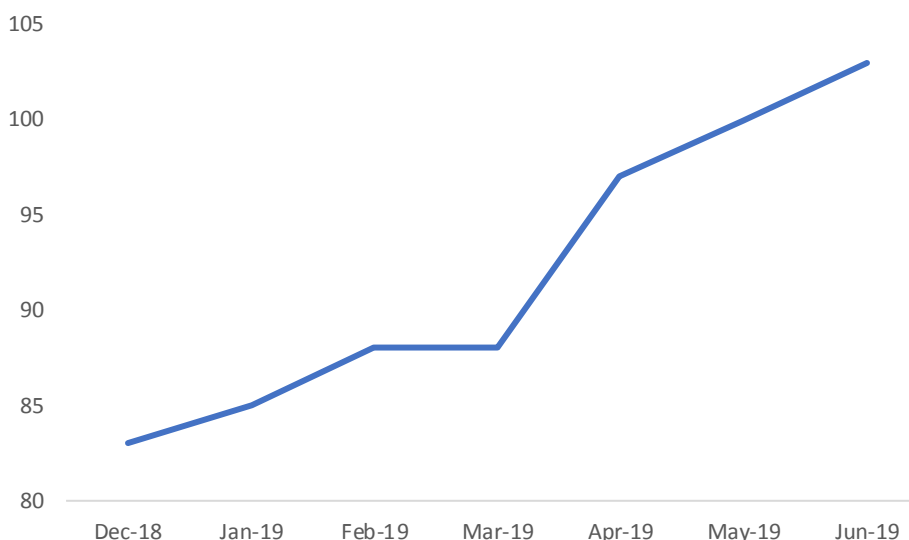
In December 2018, the US Judicial Panel on Multidistrict Litigation granted a motion to transfer and consolidate all AFFF cases pending in federal courts to the US District Court for the District of South Carolina, to be managed in multi-district litigation (MDL) proceedings – the intent being to centralize the pre-trial proceedings and expedite the legal process.

Along with 3M, other defendants named in AFFF lawsuits include Tyco Fire and Chemguard (currently part of JCI), Chemours, DuPont, Honeywell, Buckeye Fire, Saint-Gobain, Archroma, Arkema, Asahi Glass, Daikin and Solvay. Our analysis assigns 3M responsibility for 70% of AFFF remediation costs and 50% of the personal injury liability – recall 3M was the only US manufacturer of PFOS used in AFFF while it has been estimated that 3M ultimately manufactured ~85% of all PFAS globally. Consequently, this damages assignment to 3M appears reasonable.

3M, Tyco and Chemguard were reportedly in favor of consolidating the cases and DuPont was reportedly opposed to it.

The number of cases filed as part of the MDL has continued to grow over the past 3 years – reaching 88 cases per the most recent 3M 10-Q (1Q19) filing, and **over 100** per recent court filing data as of June 2019.

Figure 12: Rapid increase in AFFF lawsuits filed



Source: US District Court for the District of South Carolina, GHRA

Per 3M's 10-K filings, AFFF cases have been filed in various state and federal courts in Arizona, Colorado, Delaware, Florida, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, and Washington where current or former airports, military bases or fire training facilities are or were located.

Upon examining >100 AFFF court cases that make up the SC MDL, we were able to discern that these cases pertain to **~15-20 sites** (military and civilian) which compares with **~120 military contamination sites** identified by EWG.

At a recent South Carolina MDL Conference Hearing (held monthly), one of the attorneys reportedly asserted that *"there are about 15 to 20 sites where there is some action filed (including monitoring), but there are various reports by the DOD that have identified upwards of 400 military sites that have findings of PFOS with AFFF foam, and we have been looking State by State"*. Consequently, more lawsuits could be forthcoming.

In our Bottom-up analysis, we assume remediation and personal injury costs tied only to the 15-20 sites for which lawsuits have been currently filed.

In our Top-down analysis, we assume 120 sites highlighted by EWG (that exceed the current EPA LHA level) carry both a remediation and personal injury cost component. We do not assume that all 400 sites identified by the Pentagon will need to be remediated (these 400 sites contain some level of PFAS but may not exceed the EPA LHA level). **However, if the EPA standards were lowered, as seems likely, the number of sites used in our analysis could significantly increase.**

Importantly, AFFF contamination sites are generally situated in relatively populated areas. For the purposes of our analysis, we use a range of 10,000 to 30,000 average population per site. However, the median population of the AFFF contamination sites exceeds 30,000, implying that our cost estimates could be conservative (per Fig 8).

Figure 13: AFFF sites with pending lawsuits and associated contamination levels

	Location	Population size	PFOS/PFOA levels
1	El Paso, CO	62,686	Off-base drinking water combined PFOS/PFOA: 70-7,910 ppt
2	Warminster, PA	32,430	Off-base private wells combined PFOS/PFOA: 72-8,100 ppt; Public wells combined PFOS/PFOA: 74-1,000 ppt
3	Barnstable, MA	44,163	PFAS min - max: 0 - 864.1 ppt
4	Westfield, MA	41,700	PFAS min - max: 0 - 400 ppt
5	Fairbanks, AL	31,644	Off-base private wells (drinking water): -PFOS+PFOA: 83-2,222 ppt
6	Stuart, FL	19,000	PFAS min - max: 0 - 286 ppt
7	Newburgh, NY	28,363	Combined PFOS/PFOA 140-170 ppt
8	East Hampton, NY	21,457	One private well detected above EPA limit of 70 ppt. More test results await
9	Hampton Bays, NY	13,603	Combined PFOA/PFOS as high as 85.8 ppt
10	Burlington County, NJ	17,661	Off-base drinking water combined PFOA/PFOS: 152-1,688 ppt
11	Monmouth County, NJ	9,968	Off-base drinking water PFOA: 2.3 ppt; PFOS: 1.7 ppt; On-base groundwater combined PFOS/PFOA: 70-228 ppt
12	Trenton/ Ewing Township, NJ	36,549	On-base combined PFOS/PFOA: 178-27,800 ppt
13	Atlantic County, NJ	152,415	PFAS min - max: 0 - 196 ppt
14	Tuscon/ Marana, AZ	44,792	PFAS min - max: 0 - 476 ppt
15	New Castle County, DE	4,700	Artesian Water Co. system (drinking water): -PFOA: nd-140 ppt; PFOS: nd-1,800 ppt. United Water (drinking water): PFOA: nd-50 ppt
16	Dover, DE	37,538	Private well near base (drinking water): -PFOS+PFOA: 91 ppt; On-base monitoring wells (groundwater): PFOS+PFOA: 77-2,800,000 pp
17	Dayton, Ohio	n/a	180 contaminated wells - estimate of Ohio liability at ~3.5bn (per press reports)
18	New Hampshire	n/a	Reportedly affected population of over 100K over multiple sites
	Average	37,417	
	Median	32,037	

*Atlantic City Municipal Utilities Authority population served

** Tuscon test results are for the City of Tucson with population size 675,686; affected population only includes the Town of Marana

Source: US District Court for the District of South Carolina, EWG, GHRA

The AFFF MDL cases remain in discovery phase; the next status conference is scheduled for July 26, 2019.

Note that our overall assessment of 3M's AFFF liability presumes that the company is required to pay at least half the settlement costs of remediation and personal injury claims.

Figure 14: AFFF trial considerations

Pro AFFF defendants

3M manufactured this product per customer (government) specifications and, in turn, cannot be held as liable

There remains no proof that PFOS causes aforementioned health diseases – the C-8 study determined “probable link” with PFOA; according to experts a separate study might be required

Pro AFFF plaintiffs

3M’s claimed immunity (due to following or manufacturing to government specs) could be dismissed if proven that 3M knew about the toxicity of the products and failed to warn the customer

AFFF is shown not to have conformed to specifications

The SC MDL Plaintiff’s Advisory Counsel is the same attorney who successfully litigated against DuPont in the Leach case

Medical monitoring to establish a connection between AFFF and disease, as was required in Leach v. DuPont, could prove costly (ie, ~120 AFFF sites with a population potentially well over 10,000/site)

Source: Company Reports, GHRA

IV. Customer sites

In addition to liability pertaining to 3M's manufacturing sites, the company is facing several pending lawsuits where the plaintiffs are suing 3M's customers in addition to 3M.

Class action lawsuits have been filed in several states, including New York, where 3M is being sued alongside customers Saint-Gobain and Honeywell; Michigan, where 3M is being sued alongside its customer Wolverine; Alabama, where 3M is being sued for providing PFAS to carpet manufacturers; New Jersey, where 3M is being sued in addition to DuPont/Chemours and Honeywell.

Figure 15: 3M PFAS lawsuits related to customer sites

Location	State	Scope	Defendants	Affected population	Personal Injury	Monitoring	Total (\$ millions)
Per 3M 1Q19 10-Q							
Hoosick Falls	New York	1 putative class action/ 22 individual	3M, Saint Gobain, and Honeywell, DuPont	4,500	109.3	22.5	131.8
Cooper Township	Michigan	2 putative class actions/ 214 individual	3M, Wolverine	3,100	31.0	15.5	46.5
Coosa River	Alabama	2 public water suppliers	3M, Carpet Manufacturers	10,000	100.0	50.0	150.0
Kennebunkport	Maine	1 individual action	3M	3,600	36.0	18.0	54.0
Penns Grove	New Jersey	1 putative class action	3M, DuPont/Chemours (Chamber Works Plant), Honeywell	12,830	128.3	64.2	192.5
Filed since 1Q 19							
Blades	Delaware	5 residents file class action	Defunct metal plating company, DuPont/Chemours	5,000	50.0	25.0	75.0
TOTAL					454.6	195.2	650.0

Source: Leach v. DuPont settlement, company Reports, GHRA; Hoosick Falls assumes higher settlement rate/higher incidence of disease

Leach v. DuPont – history and implications

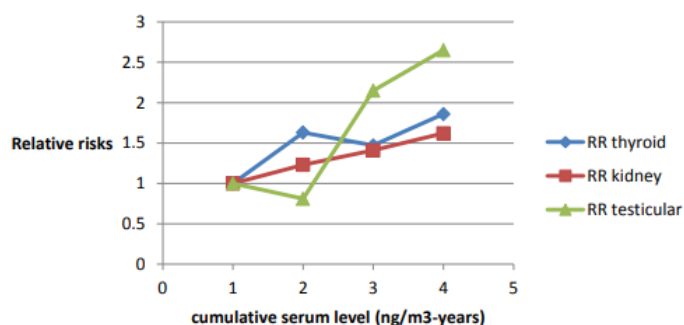
In August 2001, a class action (Leach v. DuPont) was filed in West Virginia state court alleging that residents living near DuPont's Washington Works facility had suffered, or may suffer, deleterious health effects from exposure to PFOA.

The parties reached a settlement agreement in 2004 that required DuPont to pay \$328mm (\$23mm for plaintiff attorney fees, \$70mm to fund a community health project, and \$235mm to pay for an extensive medical monitoring program). As part of that program, DuPont funded a series of health studies which were conducted by an independent science panel (the C-8 Science Panel). The panel was made up of 3 experts: Dr. Tony Fletcher of the London School of Hygiene and Tropical Medicine, Dr. David Savitz of Brown University, and Dr. Kyle Steenland of Emory University. The study ran from **2005 through to 2013**.

As part of the analysis, in-depth health histories and comprehensive blood screenings were obtained from roughly 70,000 people. Although there have been many studies of large populations that address a single medical condition or pharmaceutical impact, apparently no contamination health study has ever acquired as much medical history and/or compiled such detailed blood chemistries from a population of this size. In turn, this allowed the scientists to examine the primary profile and condition of the entire population in detail.

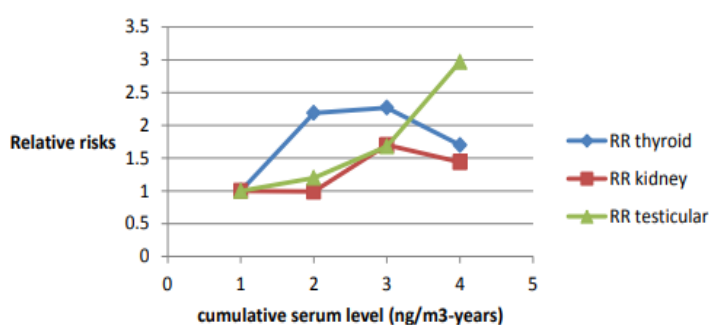
The Science Panel ultimately concluded there to be “**probable link**” between exposure to PFOA and 6 different conditions: testicular and kidney cancer, thyroid disease, ulcerative colitis, pregnancy induced hypertension, and diagnosed high cholesterol. “Probable link” was defined as more likely than not that PFOA exposure among class members is linked to the specific human disease(s).

Figure 16: Relative risks by quartile of serum levels (no lag)



Source: C-8 Science panel; medically confirmed cases

Figure 17: Relative risks by quartile of serum levels (10-year lag)



In turn, roughly 3,550 Leach class members were able to pursue injury claims against DuPont for the 6 human diseases for which the C-8 Science Panel determined a probable link exists. Out of the ~3,550 cases, this included approximately **~270 cancer cases** (8% of the all the cases filed, and 0.4% of the 70K population). Lawsuits that were filed in various state and federal courts in Ohio and West Virginia were consolidated into a multi-district litigation (MDL) in the US District Court for the Southern District of Ohio.

In the first case that was tried, a jury ruled that DuPont was responsible for the kidney cancer of a plaintiff and ordered the company to pay \$1.6mm in compensatory damages. In the second case, a jury found that DuPont acted with malice and ordered the company to pay \$5.6mm in punitive and compensatory damages. Between 2014 and 2016, three other cases were settled for undisclosed amounts. In **February 2017**, DuPont settled the MDL (and the ~3,550 injured parties) for **\$671 million**, equating to ~\$200,000/person (including legal fees), but denied any wrongdoing.

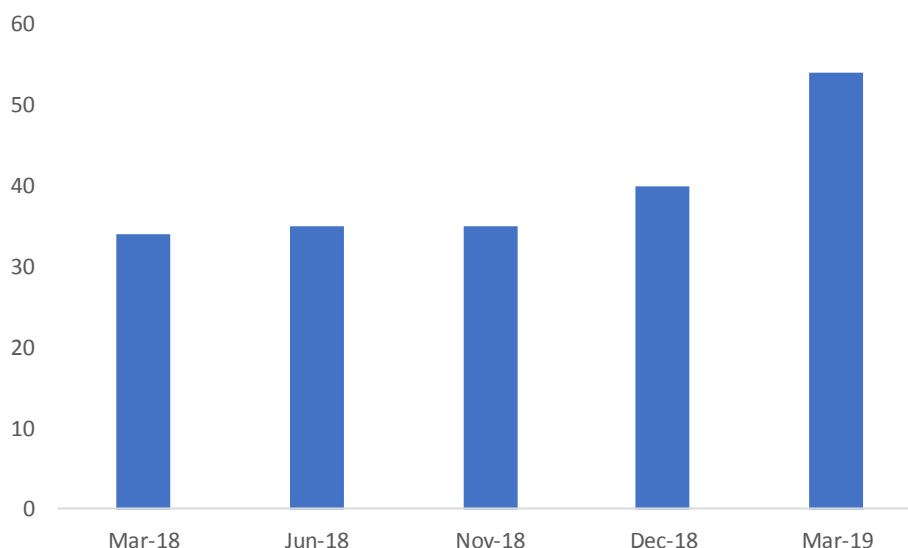
Figure 18: Leach case precedent trials (\$ millions)

	Date	Punitive Damages	Compensatory Damages	Total	Injury
Carla Bartlett	21-Dec-16		1.6	1.6	Kidney cancer
David Freeman	6-Jul-16	0.5	5.1	5.6	Testicular cancer
Kenneth Vigneron	5-Jan-17	10.5	2.0	12.5	Testicular cancer

Source: Company Reports, GHRA

Many more Washington Works cases filed outside of Leach. While the DuPont settlement has been widely telegraphed, what has not been as well understood, in our opinion, is the substantial number of cases that did not settle and/or were diagnosed with one of the 6 diseases post the settlement date of February 11, 2017. Currently, there are 54 such cases filed against DuPont/Chemours in West Virginia and Ohio. In turn, the rate of increase in post-Leach (settlement) lawsuits has been substantial, expanding from the ~30s at the beginning of 2018 into the ~50s in 2019, with a large spike in cases reported in Q1 2019.

Figure 19: Post-settlement cases filed against Chemours/DuPont



Source: U.S District Court for the Southern District of Ohio, company reports, GHRA

Nearly all the cases are pending in the current MDL in the Southern District of Ohio. According to an official at the Ohio Court assigned to the case, the vast majority of these lawsuits pertain to kidney or testicular cancer. Two of the cases are scheduled for trial in 2019 and 2020, respectively. The first final pretrial conference is scheduled for October 7, 2019.

Figure 20: Timeline for initial post Leach-settlement trials

Date	Event	Case Number
7-Oct-19	First Final Pretrial Conference in Angela and Teddy Swartz v. DuPont	2:18-cv-136
15-Oct-19	Second Final Pretrial Conference in Angela and Teddy Swartz v. DuPont	2:18-cv-136
21-Oct-19	Jury trial in Angela and Teddy Swartz v. DuPont	2:18-cv-136
6-Jan-20	First Final Pretrial Conference in Travis and Julie Abbott v. DuPont	2:17-cv-998
15-Jan-20	Second Final Pretrial Conference in Travis and Julie Abbott v. DuPont	2:17-cv-998
21-Jan-20	Jury trial in Travis and Julie Abbott v. DuPont	2:17-cv-998

Source: Company Reports, GHRA

The Leach case offers a robust precedent for assigning a cost to a PFAS personal injury settlement structure. The outcome of \$235mm for medical monitoring of a 70,000-person population (~\$5,000/person including legal fees) and \$671mm for 3,550 people settling personal injury claims (~\$200K/case including legal fees) has been used to size other PFAS personal injury lawsuits. However, this could be conservative as a future reference, considering, for instance, that a significant number of cancer cases (possibly ~50) pertaining to Washington Works were not part of the settlement and remain outstanding. In this regard, settled cancer cases would presumably come with significantly higher payout amounts (eg, the average payout of the 3 cases tried in the Leach case prior to the settlement was **\$7mm**, while the awards successively escalated).

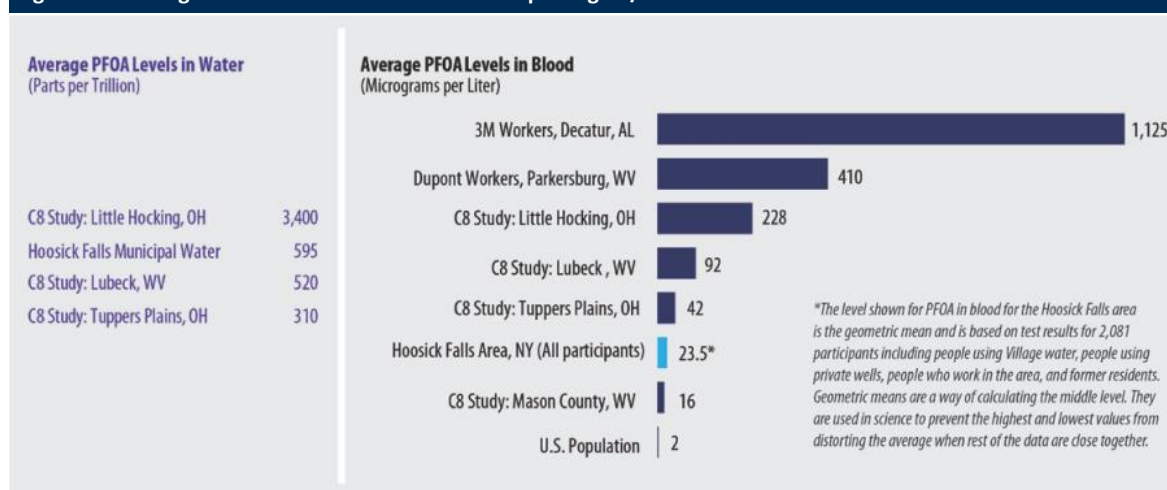
Case study: Hoosick Falls NY

The Leach settlement spurred an increase in cases filed in other jurisdictions, including Hoosick Falls NY – the site of a Saint-Gobain performance plastics facility.

In the case of Hoosick Falls, lawsuits have been filed against **customers of DuPont/Chemours and 3M** (Saint-Gobain and Honeywell) as well as DuPont/Chemours and 3M directly. Plaintiffs allege that 3M and DuPont/Chemours manufactured and sold PFOA that was used for manufacturing purposes in Hoosick Falls, which contaminated the drinking water around Hoosick Falls with unsafe levels of PFOA. Plaintiffs claim personal injuries, including kidney cancer, thyroid disease and ulcerative colitis, all of which were found to have “probable link” to PFOA per the C-8 Science Panel.

The average levels of PFOA in the Hoosick Falls municipal water system were shown to be 595 ppt, well in excess of the EPA’s 70 ppt LHA level.

Figure 21: Average PFOA Levels in water and blood per region/site



Source: NYS Department of Health, GHRA

In June 2018, the New York State Department of Health (DOH) published the results of a testing program that analyzed samples of 2,903 participants. The results showed elevated levels of PFOA in the blood of residents in the Village of Hoosick Falls, especially in the blood of residents using Village water.

Figure 22: PFOA levels in blood by drinking water source (NY DOH testing program)

	Number of participants	PFOA (mg/L)	
		50th percentile	90th percentile
All participants	2,903	26.1	123.0
By drinking water source at the time of water collection			
Currently on Village water	1,640	48.5	156.5
Not currently on Village water	1,263	8.1	44.3

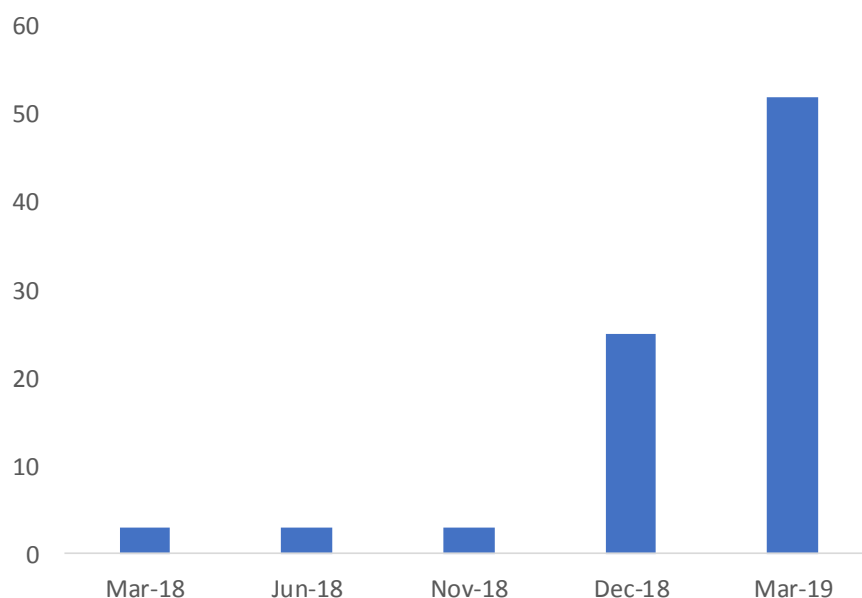
Source: NYS Department of Health; GHRA

Previously, the NYS Department of Health released the results of a statistical study in May 2017 that looked at existing regional cancer rate data in the NYS Registry over a 20-year period and found that there was not a statistically significant increase in any of the types of cancers associated with PFOA exposure, despite the elevated levels of PFOA in the drinking water.

However, a subsequent study conducted by Bennington College of residents in Hoosick Falls did find significantly higher rates of illness among residents vs. the previous study. The Bennington study identified a total of **379** injury cases afflicted with one of the six diseases identified by the Science Panel. Specifically, there were 31 incidences of kidney cancer, 11 cases of testicular cancer, 231 people with thyroid disease, 71 incidents of ulcerative colitis and 35 cases of pregnancy induced hypertension.

In addition, the number of cases related to Hoosick Falls PFAS contamination has been rapidly rising with 20-30 cases filed in each 4Q18 and 1Q19. There are currently 52 cases outstanding in courts brought by persons who live in and around Hoosick Falls, per the DuPont and Chemours most recent quarterly filings (C1Q19).

Figure 23: Hoosick Falls resident lawsuits filed against 3M, DuPont/Chemours, Honeywell, Saint-Gobain



Source: Company Reports, GHRA

Note the total number of injuries identified by the Bennington survey stood at 8.4% of the population of Hoosick Falls vs. Leach v. DuPont and Washington Works at ~5%. Furthermore, the incidence of cancer cases that the Bennington survey identified is 2x the level found in the Leach v. DuPont population (~270 cases in 70,000 population vs. ~40 cases in ~4,500 population), suggesting that ultimately settling Hoosick Falls could come in significantly higher than the ~200K/person (per Leach).

Figure 24: Instances of injury in Hoosick Falls vs. Leach

	Injuries (% of population)	Cancer cases (% of population)
DuPont Leach case	5.0%	0.4%
Hoosick Falls Survey	8.4%	0.9%

Source: Company Reports, Bennington College Survey, GHRA

Chemours vs. DuPont liability

DuPont spun-off its “performance chemicals” business into a publicly traded company, Chemours, in July 2015.

Subsequently, “Historical DuPont” and Chemours amended the Chemours Separation Agreement to provide for a limited sharing of potential future PFOA liabilities for a five-year period that began on July 6, 2017. During that five-year period, Chemours will annually pay the first \$25 million of future PFOA liabilities and, if that amount is exceeded, Historical DuPont will pay any excess amount up to the next \$25 million, with Chemours annually bearing any excess liabilities above that amount. At the end of the five-year period, this limited sharing agreement will expire, and Chemours’ indemnification obligations under the Chemours Separation Agreement will continue unchanged.

On May 14th 2019, Chemours sued DowDuPont over the spinoff and assumed liabilities (PFAS), likely related to recent expanding liabilities, litigation and regulation. On June, 28th, a Delaware court unsealed the

contents of the lawsuit in which Chemours implied that DuPont significantly underestimated the legacy PFOA liabilities in order to comply with a Delaware law requiring spin-offs to be solvent. Chemours provided several examples of how Dupont and outside advisers misestimated the liability (eg, Leach case, Fayetteville plant). Clean-up related to Fayetteville was previously estimated to cost \$2mm vs. currently the current estimate of over \$200mm. Note that Chemours' stock price declined 6% post this disclosure.

DuPont's current management views the separation agreement to be solid. However, in the case that Chemours files for bankruptcy, DuPont has stated publicly that the liability would fall to DuPont.

We believe what happens between and to DuPont and Chemours is relevant to 3M, particularly if PFAS were to be listed as hazardous substances by the EPA and fall under the auspices of the Superfund Act, per previous discussion in this report. In turn, 3M could find itself more closely drawn closer to the DuPont/Chemours legacy liability.

Punitive damages not in our analysis

There have reportedly been several environmental court cases, including Bayer/Monsanto related to glyphosate, where the courts sided in favor of the plaintiff without concrete scientific proof/evidence (eg, the EPA still considers glyphosate not to be carcinogenic).

This past May, a jury in Oakland California awarded a couple **\$2bn in punitive damages** and \$55mm in compensatory damages after concluding that sustained exposure to Monsanto's Roundup weed killer led to the couple's cancer diagnosis. In this case, much of the award was punitive damages, based on "internal documents demonstrating that, from day one, Monsanto has never had any interest in finding out whether Roundup is safe".

Recall in the Leach case, DuPont was assigned punitive damages in 2 out of the 3 precedent cases that went to trial.

3M emphasizes that the company voluntarily began the discontinuance of the manufacture of long-chain PFAS and related products in 2000, and completed the phase out by the end of 2002. However, plaintiffs are pointing to internal documents that were released as part of the Minnesota settlement that show that, for example, a 3M scientist, Dr. Richard Purdy, in 1998/99 had warned that "PFOS is the most onerous pollutant since PCB". He subsequently resigned saying "For me, it is unethical to be concerned with markets, legal defensibility and image over environmental safety".

According to 3M officials, Dr. Purdy later recanted his statement. As noted, 3M settled the Minnesota case with no punitive damages.

Likely little PFAS discounted into MMM

We believe that 3M's shares currently price in some level of risk associated with PFAS, but most likely on the remediation side (pertaining to 3M's five manufacturing facilities).

For example, we do not believe that MMM is pricing in a significantly **negative AFFF outcome**, given that these trials remain in early days (ie, lacking precedent verdicts) while the market's overall level of PFAS appreciation and awareness presumably remains cursory. Depending on how bellwether or precedent trials develop, it should be easier to more tangibly apply those results to future cases in coming periods.

Furthermore, we doubt MMM is pricing in much in the way of potential liability risk related to **personal injury** as there have too been no precedent cases/verdicts from which to more specifically gauge this exposure.

As noted, many of the experts with whom we have consulted believe that the litigation process (and implications) remain in early days and are likely to go on for several years (ie, decades). Future trend catalysts include the current AFFF MDL progress and other legal cases pending (see Fig 25).

Figure 25: 3M potential PFAS catalysts

Catalysts	Date	Description
3M : AFFF (MDL)	July, 2019	Status conferece that will potenitally have more info on timeline
DuPont: Leach Post-Settlement Cases	October, 2019	Pre trial conferencs and Jury Trial in Angela andTeddy Swartz v. DuPont
Michigan Legal Action	TBD	
EPA Regulatory Determination	end of 2019	Next step in setting MCL (Maximum Contamination Level)
DuPont: Leach Post-Settlement Cases	January, 2019	Pre trial conferencs and Jury Trial in Travis and Julie Abbott v. DuPont

Source: Court filings, GHRA

Overall, the final bill for 3M, while perhaps unlikely to create near term financial stress, could end up substantially greater than what the markets are presently assuming. Moreover, we believe PFAS increasingly injects a significant element of risk into the 3M equity investment equation – not dissimilar to the legacy issue of asbestos with other manufacturers – that appears at least likely to suppress 3M’s ability to regain a significant valuation premium for an extended period.

DISCLAIMER AND DISCLOSURE

This report is provided solely for the use of clients of Gordon Haskett. If you were forwarded this email and would like to learn more, please contact us at sales@gordonhaskett.com or +1 212 883 0824.

Copyright, Disclosures, Disclaimers, Certification and Ratings

Copyright © Gordon Haskett Research Advisors (GHRA). All rights reserved. This report or any portion thereof may not be reprinted, sold or redistributed without the written consent of Gordon Haskett.

This product is intended solely for the use of qualified professional institutional investors who are clients or prospective clients of GHRA. The securities discussed in this report may not be suitable for some investors. The appropriateness of a particular investment or strategy depends on each investor's circumstances and goals. GHRA encourages investors to independently evaluate investments and strategies, to consider this information as just one factor in their investment decision process, and to seek advice from an independent financial adviser. This report is only offered as general and impersonalized investment information and does not constitute an offer or solicitation to buy or sell.

All opinions constitute the author's judgment as of the date of this report and are subject to change without notice. Information presented is derived from sources believed to be reliable but cannot be guaranteed as to accuracy or completeness. All research reports are made available to clients simultaneously on our website. The Code of Ethics of GHRA restricts personal transactions by this report's authors in subject company shares or derivatives. Such employees and members of their immediate household may not serve as officers or directors of subject companies. GHRA employees, principals or affiliates may transact and have positions in a security mentioned in this report, and such transactions or positions may be inconsistent with the views expressed. GHRA and our affiliated broker-dealer Gordon Haskett Capital Corp (GHCC) do not trade or invest in securities on a principal basis. GHCC may transact as agent for clients in the securities mentioned herein. GHRA and GHCC do not engage in, or seek to engage in, investment banking or other business with the companies mentioned herein.

Certification: The author(s) of this report hereby certify that the views expressed herein accurately reflect their personal views regarding the subject securities and topics discussed. No part of the author's compensation was, is, or will be, directly or indirectly, related to the specific views in this report.

Ratings cover a medium to long term investing horizon. 33% of GHRA ratings are Buy, 11% are Accumulate, 39% are Hold, 2% are Reduce, and 15% are Underperform. Past ratings and target prices are no longer in effect.

Ratings and/or Recommendation Change History as on July 8, 2019

3-Year Price and Rating History for 3M Co. (MMM)

Date	CP (\$)	TP (\$)	Rating
12-Oct-18	198.23	228.00	B
11-Jan-19	192.21	213.00	B
24-Mar-19	204.66	222.00	B
29-Apr-19	190.21	185.00	B
02-May-19	184.75	185.00	H

* Asterisk signifies Initiation or assumption of coverage



Ratings Definitions: We assign one of the following ratings to our stocks under coverage. GHRA's ratings are based on our analyst's expected total shareholder return (TSR) for the stock over the subsequent 12 to 18 months, relative to the relevant broad market benchmark's TSR, on a risk-adjusted basis. TSR equals the percentage change in price from current price to projected target price plus projected dividend yield.

Buy: We expect the stock's TSR to Outperform the relevant broad market benchmarks by greater than 10%.

Accumulate: We expect the stock's TSR to Outperform the relevant broad market benchmarks by an amount less than or equal to 10%.

Hold: We expect the stock's TSR to perform in line with the relevant broad market benchmarks.

Reduce: We expect the stock's TSR to Underperform the relevant broad market benchmarks by an amount less than or equal to 10%.

Underperform: We expect the stock's TSR to Underperform the relevant broad market benchmarks by greater than 10%.

Monitored: We monitor and may comment on the company. We have no published rating, target, estimates and/or expected return, or the rating, estimates and/or target have been removed.

GHRA's ratings are intended solely for use by institutional investors. Research reports might at times include a Tactical Call, which refers to the potential near-term effect of an event or catalyst, from which we expect a short-term impact. A Tactical Call is distinct from the analyst's rating.

For additional information please [visit our website](#) or contact your GHRA representative.